

# Using Satellite Measurements to Investigate Regional-Scale Chemistry: The Case for Geostationary Observations

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## Introduction

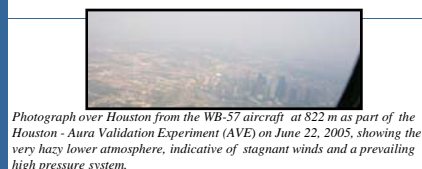
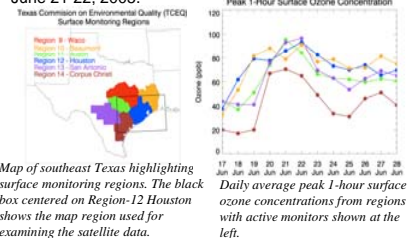
One of the recommendations of the Decadal Survey that was recently released by the National Academy of Science was that of a geostationary platform from which to obtain trace gas measurements. The use of such a platform is particularly advantageous when applied to understanding the formation of regional air pollution. This study demonstrates the challenges of trying to utilize information from instruments on satellites in low-earth orbit (LEO). We also demonstrate the advantage gained through a simulation that would provide hourly observations.

In this case study, we take advantage of the high resolution Level-2 orbital data available from the Ozone Monitoring Instrument (OMI), in conjunction with assimilated stratospheric column ozone fields, to evaluate if meaningful tropospheric ozone information can be obtained on a regional scale.

We focus on a period in late June 2005 when a widespread pollution episode enveloped the Houston metropolitan area as well as a large region in southeast Texas.

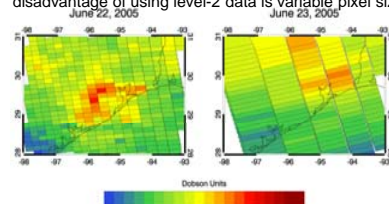
## June 2005 Case Study

Surface ozone monitors confirm highest ozone levels on June 21-22, 2005.



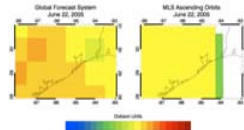
## Method

The tropospheric ozone residual (TOR) product derived for this study uses level-2 OMI total ozone data. A disadvantage of using level-2 data is variable pixel size.

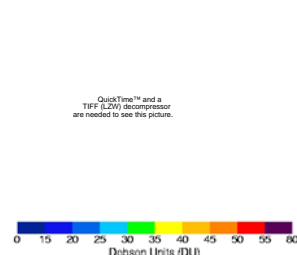


Level-2 OMI Total Ozone over southeast Texas on consecutive days highlighting pixel footprint size.

The stratospheric product used in the TOR method is primarily the NOAA Global Forecast System (GFS) assimilation of SBUV ozone profiles. The resolution of the assimilated product is  $1^\circ \times 1^\circ$  which has superior temporal and spatial resolution compared to satellite measurements alone. An independent measurement from the Microwave Limb Sounder (MLS) instrument shows that the model is within 2 - 4 DU of the integrated MLS ozone profile on June 22, 2005.



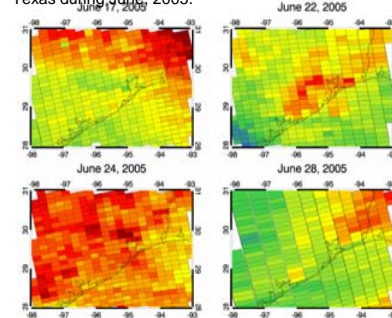
Stratospheric column ozone calculated from the GFS (left) compared with MLS measurement (right); 2 MLS nadir points are represented in the image.



Global TOR product for June 2005 computed using OMI and MLS (top) and OMI with the GFS-generated stratospheric column (bottom).

## Results

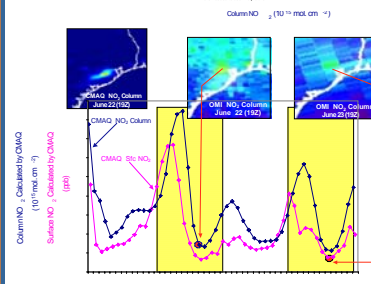
The TOR images from June 17, 22, 24, and 28 show the evolution of an air pollution episode over southeastern Texas during June, 2005.



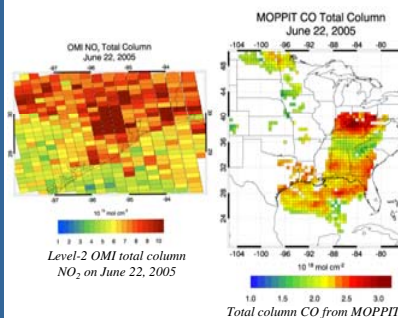
OMI-GFS TOR over southeastern Texas for 4 days in June, 2005.

## Advantage of Geostationary Orbit

In addition to the shortcomings of the variable spatial scale of OMI on a day-to-day basis, daily LEO observations cannot capture hourly variability of trace gas evolution (large red circles). Using BUV techniques, GEO observations of  $\text{NO}_2$  would be made during daylight hours (yellow) as shown by blue diamonds.



Additional satellite measurements from OMI confirm elevated  $\text{NO}_2$  over the region on June 22, 2005. Measurements of CO from MOPITT instrument show elevated CO total column values over southeastern Texas and Louisiana and the Gulf of Mexico.



## Conclusion

The combination of Level-2 OMI total ozone and assimilated stratospheric ozone fields can be combined to produce a regional TOR product which can then be compared with EPA surface ozone measurements and additional satellite measurements of tropospheric pollutants. Combining measurements from several ground-based and satellite products prove to be difficult due to variable temporal and spatial scales. The use of the GFS model provides TOR values similar to what can be provided from direct MLS measurements. However, the best way to observe regional scale atmospheric chemistry is from geostationary orbit.

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